Randomized Clinical Trial Comparing Dietary Intake in Patients with Implant-Retained Overdentures and Conventionally Relined Dentures

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Purpose: This study compared the dietary intake of edentulous subjects dissatisfied with their existing mandibular complete dentures following two different prosthodontic management interventions. ***Materials and Methods:*** A convenience sample of 60 subjects was randomly allocated into two equal treatment modalities: relined conventional denture (RCD) or converted implant-retained overdenture (IOD). Two-year data incorporating demographics and food avoidance were recorded using a self-administered questionnaire at baseline and regular follow-up intervals. Twenty-four-hour dietary intake assessments were obtained by telephone interviews at three spaced intervals. Dietary analyses were based on nutrient values from the Norwegian Food Composition Table. ***Results:*** Twenty-seven patients in the IOD group and 26 in the RCD group completed the protocol. There were no statistical differences regarding dietary intake and energy distribution. Intake of protein and fat, especially saturated fat, were above Nordic recommendations, and carbohydrate intake was below. Vitamin D intake was at the recommended level, but that of vitamin C, folate, and fiber were lower than recommended. The IOD group reported significantly less avoidance of certain food items at 3 and 24 months ($P < .001$), better chewing ability ($P < .001$), and greater willingness to eat more of some food items ($P < .001$). ***Conclusion:*** There were no significant differences regarding food choices and nutrient intake between the IOD and RCD groups. However, the IOD group reported significantly better chewing ability, less food avoidance, and greater willingness to eat more of certain food items. *Int J Prosthodont 2012;25:340–347.*

The dietary intake and nutritional status of complete denture wearers are reported to be inferior to those of dentate individuals of comparable ages.[1] Complete denture wearers seem to adjust their diet toward food items that are less coarse, softer, and easier to chew, and they generally consume less fruits and vegetables. This change in diet affects nutritional status, and generally, complete denture wearers have a lower energy intake than dentate individuals. Intake of macronutrients such as protein and fiber are lower and the intake of fat is higher. Furthermore, the intake of micronutrients such as vitamin C, vitamin E, vitamin A, calcium, and folate are often low in this group of older adults. In addition, edentulous adults having functional problems with their mandibular dentures experience even further changes in dietary intake than do denture wearers with well-functioning prostheses

The prevalence of complete edentulism in Norway is declining. In the late 1990s, it was estimated that approximately 30% of a national representative sample older than 67 years of age wore complete dentures.[2] Today's proportion is estimated to be 2.5% in the age group of 30 to 76 years.[3] On the other hand, the elderly population continues to increase in most countries, and nutritional imbalance is a common problem affecting their functional and physical status.[4]

The use of implants in edentulous arches makes it possible to improve retention and stability of complete dentures. The results of a series of studies published over the past 20 years on mandibular implant-retained overdenture treatment indicate improved masticatory ability but minor influence on food choices

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and nutrition.[5–10] Even though these results apparently concur, they are difficult to compare and interpret because of differences in study designs, and the magnitude of the apparent effect is still uncertain.[11] Not all studies were randomized, and only some studies recorded actual food intake.[7–9] Instead, preferences of listed food items were reported.[5,6] However, reporting of actual food intake must be regarded as a more reliable variable. A retrospective 24-hour recall telephone interview by a trained interviewer is regarded as a valid method of assessing dietary intake in elderly individuals.[12] In studies comparing implant-retained mandibular overdentures and conventional mandibular dentures, the patients were in need of and provided with new maxillary and mandibular dentures.[5–8,10] This may influence and complicate the outcome assessment, since the replacement of both dentures with new ones may involve expectations of treatment effects other than those limited to retaining the mandibular denture. Finally, the degree of patient satisfaction with dentures prior to treatment with implants may also be of importance in this type of study, since dissatisfaction might partially be caused by deficiencies in function of either or both dentures. It is therefore difficult to estimate the true effect of the use of implants retaining a complete mandibular denture per se.

This study was designed to control and reduce these methodologic problems. The aim of this study was to assess and compare the dietary intake in two groups of edentulous adults dissatisfied with their existing mandibular dentures; one group had their dentures conventionally relined, while the other had their mandibular dentures converted into implant-retained prostheses.

Materials and Methods

The study was designed as a randomized 2-year longitudinal clinical study in which the selected edentulous subjects were randomly allocated into one of two different treatment modalities for the mandible: implant-retained overdenture (IOD) or relined conventional denture (RCD). The study was performed at the Centre for Clinical Dental Research, Faculty of Medicine and Dentistry, University of Bergen, Bergen, Norway.

Study Sample

Patients were selected on the basis of their histories of wearing complete dentures in both arches, with an accompanying complaint of dissatisfaction with their mandibular prosthesis, as well as being ≤ 76 years of age. In addition, the dentures needed to be of acceptable technical quality: no defects of teeth, denture base, fit, occlusion, or articulation and with acceptable vertical dimension. Furthermore, there could be no visible plaque on the dentures or signs of irreversible stomatitis or tissue hyperplasia, and the gingiva could be displaced only slightly by palpation. These criteria were assessed by four specialists in prosthodontics with long-term joint clinical and teaching experience at the university dental clinic, during which they had become gradually calibrated. Verification of calibration was done prior to the study, during which each prosthodontist separately assessed the mentioned prosthetic variables in 10 patients from the Section of Prosthodontics, Department of Clinical Dentistry, University of Bergen. When assessments differed, complete agreement was reached after reassessment and discussion. Patients needed to have acceptable general health, be cooperative and communicate easily, smoke fewer than 20 cigarettes per day, and have no general or local contraindications to inserting two intraosseous implants in the mandible. These criteria were assessed by a specialist in oral surgery.

A convenience study sample was recruited during two periods between 2006 and 2008. In the first recruitment period, former patients (n = 176) treated with complete dentures in either or both arches at the Section of Prosthodontics, Department of Clinical Dentistry, University of Bergen, were invited to an examination; 116 were completely edentulous. Details of this patient cohort are described in a previous publication.[13] The second recruitment was made by advertising for participants in seven newspapers in Bergen and nearby regions as well as through referrals from dentists in Bergen. Eighty-five edentulous individuals responded during this second recruitment period and were invited to a clinical examination.

Figure 1 shows the flowchart of the process of selecting participants. As a result of this process, 16 subjects from the first recruitment and 44 from the second constituted the final study sample. To ensure even treatment distribution in each of the two groups, the patients from the first recruitment blindly drew a ticket from an original stack of 16 to determine treatment allocation, with 8 tickets for each of the two treatment modalities. The same procedure was followed for patients from the second recruitment; each patient drew a ticket from an original stack of 44, with 22 for each treatment modality.

To avoid possible expectations with a specific treatment modality, the patients were first only generally informed of the aim of the study. Subsequently, they were informed in full, but only regarding the specific treatment they were assigned to. All treatments were

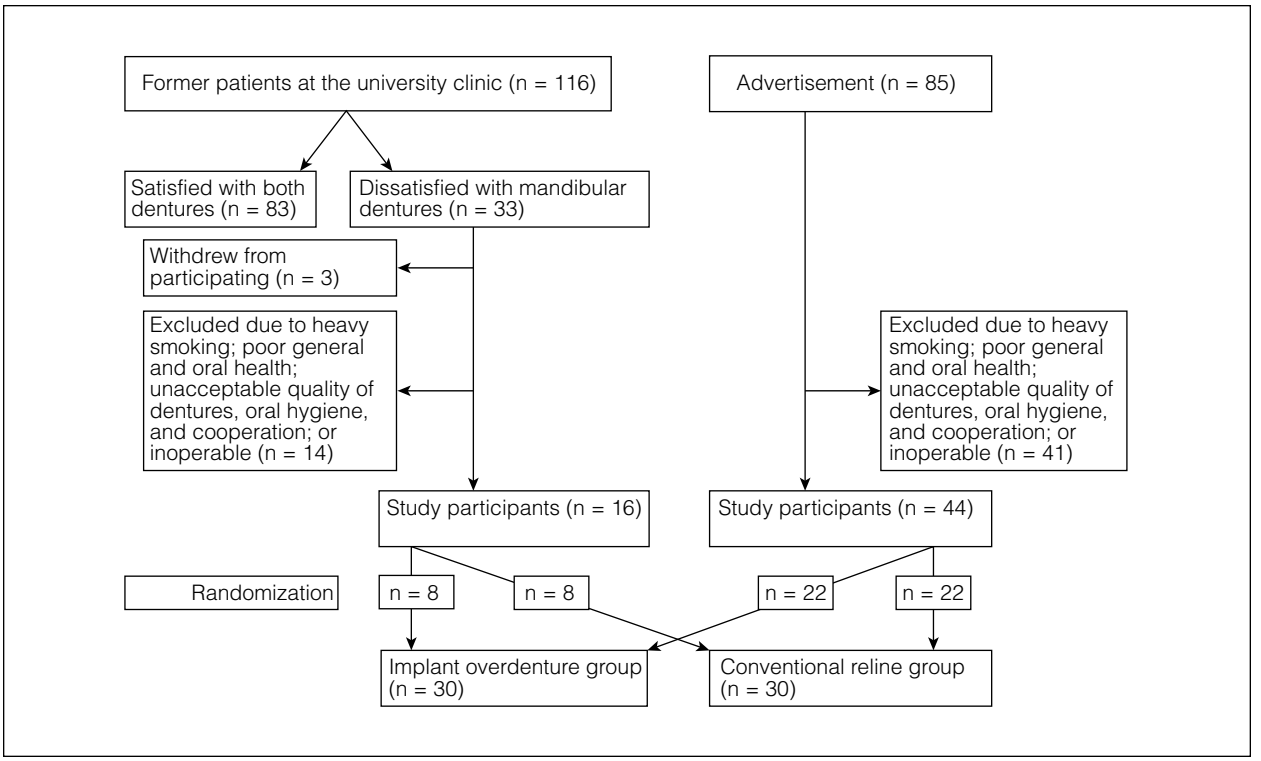

Fig 1 Flowchart of patient recruitment.

offered at no cost, and patients were guaranteed free treatment with the alternative treatment modality after the study period of 2 years if they so wished. Patients could also withdraw from the study at any time without consequence. An informed consent form to join the study was then signed.

In the IOD group, two Astra OsseoSpeed implants (Astra Tech) were placed using a standardized single-step surgical technique. Six weeks later, Locator abutments (Zest Anchors) were placed. Existing dentures were relined with Vertex self-curing acrylic resin (Vertex Dental), during which Locator patrices were mounted. The mandibular dentures in the RCD group were indirectly relined using the same materials. All clinical procedures were performed by one specialist in oral surgery and the first author.

Dietary Assessments

Three unannounced 24-hour dietary recalls, Tuesdays through Fridays, were obtained by telephone approximately 4, 8, and 11 months after treatment. Trained personnel conducted the interviews, and a structured template was used to collect detailed information on dietary intake during the previous 24 hours. These data were entered into a free computer program ("Food on data," Mattilsynet) based on nutrient values from the Norwegian food composition table.[14,15] The mean dietary intake for the three 24-hour recalls was used to calculate intake of energy, fat, protein, carbohydrates, vitamins, and minerals. Fat, protein, and carbohydrates were also expressed as a proportion of the energy content of the diet of each macronutrient (E%). The group mean values were compared with current Nordic Nutrition Recommendations (NNR).[16]

Food items reported by at least one participant at one or more interviews are listed in Table 1. For the purpose of analysis, the variables were dichotomized as not eaten or eaten. During the 24-hour recall interviews, patients were additionally asked if the treatment they had received had made a difference in terms of masticatory ability or in the amount of any food items consumed. They were also asked how many times per week they had fish at their main meal.

Self-administered Questionnaire

The questionnaire included demographic items, the patients' heights and weights, whether they avoided certain food items because of their dentures, and the year they had become completely edentulous. The

number of years they had been completely edentulous and Body Mass Index values were then calculated. The question on food avoidance was open-ended and later coded as yes or no; the number of years completely edentulous was dichotomized into 1 to 10 years or more than 10 years. The questionnaire was completed at baseline and at clinical controls after 3 and 6 months and 1 and 2 years.

The study protocol was approved by the Regional Committee for Medical Research Ethics in Norway, Health Region West (reference no. 05/8161), and registered at the Norwegian Social Science Data Services.

Statistical Analysis

Statistical analyses were performed using PASW Statistics 18 (SPSS). Standard descriptive statistics including cross tabulations were calculated, and the two-sample *t* test, Mann-Whitney *U* test, chi-square test, and Fisher exact test were all applied to further analyze the data. The significance level was set at 5%.

Results

Throughout follow-up, four patients completed two or fewer of the three 24-hour recalls and were excluded from further analyses. Furthermore, one patient lost one implant and underwent additional surgery, one patient died, and one patient withdrew from the study. This left a study sample of 53 patients—27 in the IOD group and 26 in the RCD group. Two patients in the IOD group did not answer the questions regarding change in type of food or amount of any consumed food items.

Baseline Data

The IOD group included 17 women and 10 men with a mean age of 68 years (range: 48 to 78 years), whereas the RCD group included 16 women and 10 men with a mean age of 67 years (range: 52 to 78 years).

There were no significant differences between groups regarding sex ($P = .92$) or age ($P = .90$). Considering the 24-hour recalls, there were no significant differences between the groups regarding weekdays, seasons, and intervals between or length of interviews ($P > .10$ for all comparisons). There were no significant differences between the groups regarding mean time spent edentulous (22.8 vs 19.6 years, range: 1 to 49 vs 3 to 43 years; $P = .56$) or whether they had been edentulous for more or less than 10 years. There was also no significant difference between the groups in avoiding food items ($P = .61$) (Fig 2) or in mean Body Mass Index values (25 ± 4, $P = .40$).

Table 1 No. of Patients Reporting Eating Specific Food Items at 24-Hour Recalls

	No. of reportings				
	0	1	2	3	Total
Bread (firm)	44	3	5	1	9
Bread (coarse)	3	6	11	33	50
Meat spread	19	11	14	9	34
Meat (dinner, firm)	33	17	2	1	20
Fruit (hard, firm)	32	11	7	3	21
Vegetables (raw, hard, firm)	43	8	2	0	10
Sweets (hard, firm)	49	4	0	0	4
Nuts	48	5	0	0	5
Bread (soft)	28	12	5	8	25
Cereals	1	8	16	24	49
Cake	18	14	17	4	35
Milk products	0	0	1	52	53
Meat (dinner, soft)	21	15	11	6	32
Sandwich spread (soft)	3	10	14	26	50
Fish (dinner)	14	17	20	2	39
Fruit (juicy, soft)	11	19	11	12	42
Juice (beverage)	32	13	4	4	21
Vegetables (raw, soft)	31	15	6	1	22
Vegetables (boiled)	11	16	16	10	42
Sweets (soft)	34	11	6	2	19
Eggs	25	18	5	5	28

Posttreatment Data

The IOD group reported significantly lower prevalence of food avoidance at all controls than the RCD group (Fig 2). Similarly, at the 24-hour recalls, more patients in the IOD group reported improved masticatory ability (84%, n = 21 vs 23%, n = 6) (Fig 3) and improved capability to consume more of certain food items (72%, n = 18 vs 23%, n = 6) (Fig 4) ($P < .001$ for all three comparisons). However, the mean Body Mass Index did not change in either group at any of the controls.

There were no significant differences between the groups regarding reported consumption of the main food items listed in Table 1 ($P > .11$). The intake of fish was rather high; 79% of participants consumed at least two servings per week and 53% at least three servings per week (Fig 5), but no significant difference was found between the groups ($P = .67$).

Patients who had been edentulous for more than 10 years ate more firm bread ($P = .021$) and soft, raw vegetables ($P = .002$) and less eggs ($P = .018$) than those

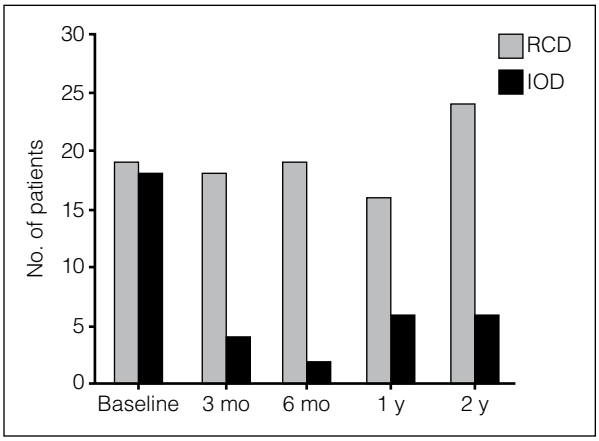

Fig 2 Number of patients in each group avoiding at least one food item at baseline and regular controls.

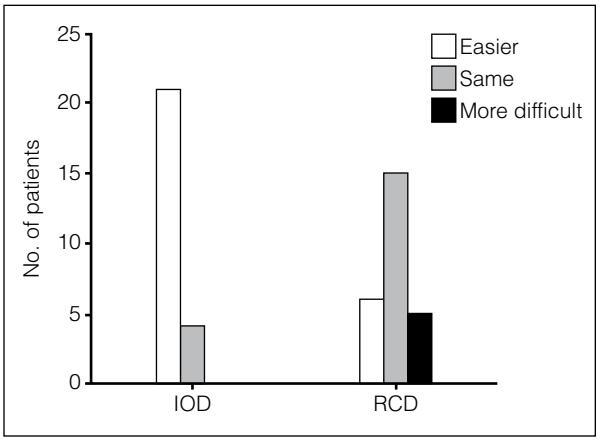

Fig 3 Number of patients in each group reporting change in masticatory ability after prosthetic treatment.

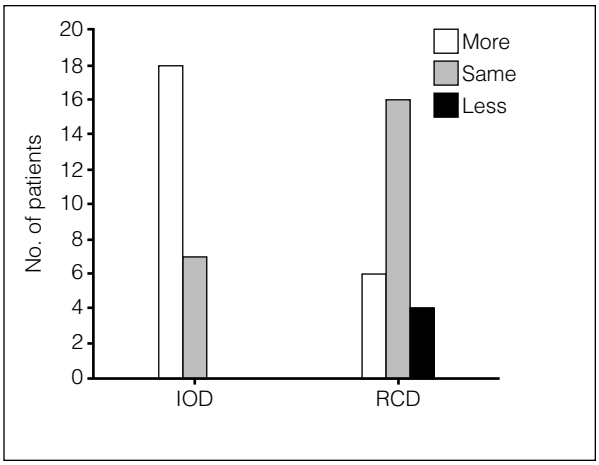

Fig 4 Number of patients in each group reporting change in consumed amount of at least one food item after prosthetic treatment.

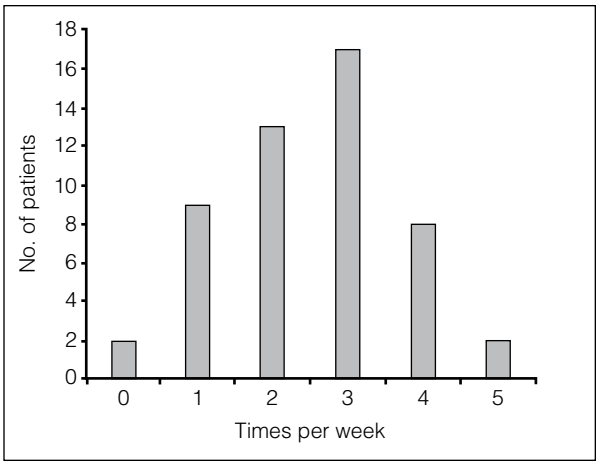

Fig 5 Number of patients reporting to consume fish at the main meal up to five times each week.

who were edentulous for less than 10 years. However, in the IOD group, the only significant difference noted was regarding soft, raw vegetables (P = .001). In the RCD group, no differences were significant regarding years edentulous.

Table 2 shows the calculated energy intakes of the different macronutrients and vitamins by the study sample compared with the NNR. No significant differences were found in mean energy, fat, protein, carbohydrate, or vitamin intakes between the treatment groups; hence, further analyses were carried out for the entire study sample.

As many as 87% of patients had over 30 E% of energy intake from fat, and 98% of patients had an intake of saturated fat over the recommended 10 E%. Regarding protein, 80% of patients had a protein intake above the recommended 15 E%. As for carbohydrates, 98% of patients had an intake below the recommended 55 E%, and 62% of patients had an intake below 45 E%. The mean fiber intake was only half of the recommendation; 96% had an intake below the recommended daily intake of 25 g. The mean vitamin D dietary intake was almost in accordance with the Nordic recommendation; nevertheless, 75% of patients had an intake below the recommendation. Most patients (64%) reported taking dietary supplements, with an average dose of 7 μg of vitamin D per day. Therefore, the total mean daily intake of vitamin D was 16 μg, and 62% of patients had more than the recommended intake. The mean intake of folate was approximately only half of the recommendation, and no patient reached the recommended intake.

The mean energy intake was 8,162 kJ for men and 5,765 kJ for women, which was a significant difference (P < .001). Ninety percent of men and 97% of women were below the Nordic recommendations. The difference between the sexes was also significant in that men had higher energy intake from fat (P = .022),

especially from saturated fat (P = .004), than women, who had a higher energy intake from carbohydrates (P = .022). The mean energy intake was not significantly associated with time edentulous (P = .30).

Discussion

There are several tools that can be used to assess nutritional intake in epidemiologic studies, such as the food frequency questionnaire[10–17] and 3- and 7-day recalls.[5–7,9] Most of them have been developed for use in younger subjects.[18] However, the 24-hour recall method has also been validated for assessing dietary intake in older adults.[12] The food frequency questionnaire covers a long time period and relies on memory, whereas 3- and 7-day recalls are more accurate for assessing absolute intake of nutrients. Even though the 24-hour recalls rely on memory and might not be as accurate in assessing dietary intake, the results of this study are in accordance with those from similar studies with different methods of dietary assessment. Therefore, there is no indication that the use of repeated 24-hour recalls in this study has biased the results.

Despite the obvious difference in terms of ability to comminute, there were no significant differences between the two treatment groups regarding the intake of energy or any of the nutrients. However, this perhaps unexpected result is corroborated by several other similar reports in which no difference was found between overdenture and conventional denture treatment.[19,20]

The energy intake for both women and men was low, ranging between 5,765 kJ and 8,162 kJ. In fact, most participants had an energy intake below the recommended 8,500 kJ and 10,600 kJ per day for women and men, respectively, between the ages of 61 and 74 who had a moderate level of physical activity.[16] Comparable results from other studies of edentulous patients wearing complete dentures show a low mean energy intake between 6,700 and 8,500 kJ per day.[19,21] These figures are considerably lower than those from a Norwegian national dietary survey,[17] which showed the energy intake in the age group of 60 to 69 years to be 7,500 kJ for women and 9,700 kJ for men. In other studies on edentulous adults wearing mandibular overdentures, a mean daily energy intake between 6,600 and 10,900 kJ was reported.[7,9] However, in these studies, the methods of recording dietary intake were different from the present one. Despite the seemingly low energy intake in this study, patients were all of normal weight, as assessed by the Body Mass Index.

The proportions of energy were higher for proteins and fat and lower for carbohydrates than those recommended by the NNR. The intakes of protein and fat were also higher than those recorded for individuals aged 60 to 69 years in a national Norwegian survey,[17] the results of which were close to the recommendations.

One study of diabetic patients wearing implant-retained overdentures showed almost the same total energy intake as in the present study.[9] However, in the former, there was greater intake of protein and less of fat. Other studies among edentulous subjects indicate relative composition of macronutrients and energy intake almost in accordance with the recommendations.[7,19] The high intake of fat, especially saturated fat, might be related to the regular intake of dairy products and the somewhat frequent consumption of cakes shown in Table 1.

The mean fiber intake of 15 g per day is considerably lower than normative Norwegian values[17] (mean: 21 to 26 g per day) but is still in accordance with those

Table 2 Intake of Energy, Macronutrients, and Vitamins Calculated Based on 24-Hour Recall Data

	Mean	SD	NNR
Energy (kJ)	6,670	2,295	8,500–10,600
Amount (g)	2,307	1,137	NA
Protein (g)	72	29	NA
E %	19	3	15
Fat (g)	68	28	NA
E%	38	5	30
Saturated fat (g)	26	15	NA
E%	15	4	< 10
Monounsaturated fat (g)	26	8	NA
E%	14	9	10–15
Polyunsaturated fat (g)	14	7	NA
E%	9	5	5–10
Carbohydrate (g)	164	51	NA
E%	43	6	55
Starch (g)	88	31	NA
Added sugar (g)	30	25	NA
E%	8	6	< 10
Fiber (g)	15	5	25–30
Vitamin C (mg)	68	46	75
Folate (mg)	157	63	300
Vitamin D, diet (μg)	9	8	10*
Vitamin D, supplements (μg)	7	6	

SD = standard deviation; NNR = Nordic Nutrition Recommendations; NA = not available; E% = proportion of total energy intake.
*Value for vitamin D from diet and supplements combined.

found in other studies on edentulous subjects.[9,19] The present intake of vitamin C cannot be considered adequate since the majority of patients (70%) fell below the Nordic recommendation of 75 mg per day. The intake of folate, with a mean value of 157 mg, was especially low since none of the patients had an intake of 300 mg per day, as recommended by the NNR. This is in contrast with other studies of edentulous Americans in which the folate intake was between 270 and 476 mg per day.[9,19] The low values are probably related to the low intake of firm fruit and raw vegetables reported by the majority of patients (see Table 1). This circumstance, not compensated for by the intake of soft fruit and boiled vegetables, may in part explain the low intake of fiber, vitamin C, and folate.

The relatively high intake of vitamin D is approximately twice the level reported in a comparable American study.[7] This may in part be explained by differences in diet between the two countries, particularly with regard to the high intake of fish in a Norwegian diet, as documented in Table 2 and Fig 5. Similar regular intake of fish is also reported in another Norwegian survey.[17] Other possible causes of the present high intake of vitamin D may be the reported regular intake of margarine and butter, which are fortified with vitamin D, and eggs, which were eaten by more than half of patients once or more a week. In addition, most patients (64%) commonly used dietary supplements containing vitamin D (Table 2), which brings the total mean vitamin D intake above Nordic recommendations.

As opposed to the previous results, marked differences between the treatment groups were found with regard to self-reported oral function. Thus, after treatment, the IOD group reported a marked improvement regarding avoidance of food (see Fig 2), masticatory ability (see Fig 3), and the ability to eat more of certain types of food (see Fig 4). In the RCD group, no such change could be discerned. It may seem like a paradox that this significant subjective improvement in oral function as well as improved self-evaluated mechanics and ability to comminute food do not influence dietary intake in the IOD group; however, the present findings are in accordance with other studies.[6,7,9] That conventional denture wearers sometimes report improved masticatory ability[21] is probably a result of the patients receiving new dentures.

Part of the reason why the IOD group did not change their food intake may be that dietary habits change gradually over time as people adapt their food selections and diets to a gradually deteriorating dentition and oral function. Such a change is likely to become apparent in completely edentulous individuals, who wear dentures with inferior function compared to the natural dentition. After they have become firmly established, dietary habits are resistant to change, regardless of improvements in the ability to comminute food. In this study, the mean time spent edentulous was rather long and might be part of the explanation for there being no significant difference between the groups. It would appear that important aspects for food choices among older patients include tradition, personal taste, ease of preparation, cost, and social settings, regardless of problems with the mouth and dentures.[22] However, there is evidence that dietary counseling in addition to prosthetic treatment may have an effect on food choices and dietary habits.[20]

Conclusions

Within the limitations of this study's research design, the results suggest that there is no difference in dietary intake between edentulous patients wearing a relined complete mandibular denture and those wearing a mandibular implant-retained overdenture. Moreover, the nutrient intake in both groups was not in accordance with national recommendations. The overdenture group, as opposed to the relined group, reported a markedly subjective improvement in masticatory ability, an increase in the amount of food items consumed, and a reduction in food avoidance.

Acknowledgments

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Literature Abstract

Long-term results of mandibular implants supporting an overdenture: Implant survival, failures, and crestal bone level changes

The objective of this study was to summarize the long-term clinical observations of edentulous patients treated with two or three mandibular implant-supported overdentures. From 1984 to 1997, edentulous patients were consecutively admitted for treatment with mandibular implant overdentures. The treatment plan was to connect the dentures to only two implants by means of single ball anchors or bars; in patients with special oral conditions, three implants would be placed. Implant failures were described according to clinical signs at the time of removal and related to the patient's specific history. Crestal bone measurements were obtained using computer software (Dimaxis Pro version 4.3.2, Planmeca). The results showed that 147 completely edentulous patients (45 men and 102 women) with 314 implants were evaluated for 10 to 24 years. Of these, 101 patients were still available for clinical review. Thirteen implants failed during the observation period, resulting in a cumulative survival rate of 85.9% after 24 years. The reasons for removal of implants were peri-implantitis (2 implants) and mobility (11 implants). Mean crestal bone loss was 0.54 ± 0.7 mm per implant site after a mean observation period of 16.5 ± 3.9 years. The duration of loading had a statistically significant effect on crestal bone loss. The authors concluded that the data exhibited a satisfactory survival rate for interforaminal implants. An individual analysis of implants with late failures did not show a typical failure pattern, but loss of implants without signs of infection was more frequent than loss of implants with signs of peri-implantitis.

Ueda T, Kremer U, Katsoulis J, Mericske-Stern R. *Int J Oral Maxillofac Implants* 2011:26:365–372. **References:** 37. **Reprints:** Prof Dr Regina Mericske-Stern, Department of Prosthodontics, School of Dental Medicine, Freiburgstrasse 7, CH-3010 Bern, Switzerland. Email: regina.mericske@zmk.unibe.ch—*Arthur S. Sham, Hong Kong*